APPLICATION VOID.
This print shows the Specification as it became open to public inspection under Section 91 (4) (a) of the Patents and Designs Acts, 1907 to 1932.

PATENT SPECIFICATION

Convention Date (United States): April 15, 1936. **498,912**

Application Date (in United Kingdom): April 12, 1937. No. 10362/37.

Specification not Accepted

COMPLETE SPECIFICATION

Improvements in Method and Apparatus for Preserving Products of the Soil

We, TOLEDO SCALE MANUFACTURING COMPANY, a corporation organized and existing under the laws of the State of New Jersey, United States of America, engaged in business as Manufacturers, with a principal place of business in the City of Toledo, County of Lucas, State of Ohio, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates generally to an improved method and apparatus for preserving products of the soil, such as fruit and vegetables. In our Patent No. 240,507 there is disclosed a method which is adapted to maintain the vitality of produce, yet to keep it in a dormant state by reducing respiration, and the consumption of carbohydrates incident thereto, to the lowest rate compatible with the health of the plant. Methods employing refrigeration to low temperatures, on the other hand, either kill produce or reduce its vitality to such a degree that decay proceeds rapidly when it is removed from storage. In an attempt to avoid deterioration, marketers of fruit have adopted the practice of shipping immature products that have been "treated" to give them an appearance of maturity.

Treatment of fruit with ethylene, like refrigeration to freezing temperatures, kills the fruit as well as the fungi, and destroys its vitamins. When fruit is kept in a living, healthy condition during storage, it is just as capable of resisting diseases as it was while still on the tree, for fruit on the tree is entirely cut off from the sap supply during the final stage of ripening. It is only necessary for the produce to be kept at moderate temperatures, in air of suitable relative humidity that is renewed at a rate approximately just sufficient to keep the carbon dioxide concentration near that of the outer atmosphere and preferably below 0.1%.

The produce is thus kept in a healthy condition, with no abnormal respiration such as either greater or less air flow would cause. The spread of rot from bruises is cut down, and the building up of protective scar tissue by drying out of injured plant cells is permitted to proceed, the spread of decay being thereby further inhibited. The patent referred to discloses a method of passing air through stored produce that is quite satisfactory for moderate quantities of produce, when the relative humidity and temperature are kept within the range specified in the patent. However, the problem of securing proper distribution of the air flow is increasingly difficult with large storage chambers, holding great quantities of produce.

The principal object of the invention is to provide a method of preserving products of the soil that is simpler than the method of British Patent No. 240, 507, in that the air to be passed over the products is withdrawn directly from the outer atmosphere, and in that no control of the temperature or relative humidity is required, although the rate of air flow may be controlled for the purpose of preventing injury to the products by certain kinds of temperature changes.

Another object of the invention is to provide apparatus for carrying out this simpler method.

The invention consists in a method of preserving products of the soil that comprises continuously withdrawing air from the outer atmosphere, distributing it to produce a substantially uniform flow, and then passing it through the products at a rate that is approximately just sufficient to keep the carbon dioxide concentration near that of the outer atmosphere, to hold the relative humidity within a proper

[*Price* 1/-]

range and to prevent rapid changes in temperature.

The invention also consists in apparatus for preserving products of the soil comprising a storage compartment for such products, means for continuously withdrawing air from the outer atmosphere and passing it through the compartment at a rate that is approximately just sufficient to keep the carbon dioxide concentration in the compartment near that of the outer atmosphere, and means for distributing the air so that it passes through the compartment in a uniform flow, to prevent the temperature in the compartment from varying as rapidly as the temperature of the outer atmosphere.

Referring now to the accompanying drawings:

Fig. 1 is a vertical section of a small cabinet for preservation of products of the soil in accordance with the invention.

Fig. 2 is a horizontal section taken on line 2—2 of Fig. 1.

Fig. 3 is a vertical section of a large compartment such as a freight car for preservation of products of the soil in accordance with the invention; and

Fig. 4 is a wiring diagram of an electrical system for automatically controlling the supply of air to the compartments of Fig. 1 and Fig. 3 in accordance with the invention.

These specific drawings and the specific description that follows merely disclose illustrative applications of the invention, and are not to impose limitations upon the claims. In order that highly uniform distribution of the air may be secured, it is preferably introduced through equal sections of the floor of the compartment at an approximately equal rate, and withdrawn through the top wall of the compartment in a similar manner. When the air passing through the compartment is thus uniformly distributed, control of temperature and relative humidity is unnecessary, and the entering air may merely be withdrawn slowly and continuously from the outer atmosphere.

Limitation of respiration by restriction of the air supply to the produce makes the relative humidity of the air relatively unimportant, for depletion of the free moisture content of the produce can be remedied by reabsorption of water from the air, although water generated by oxidation of carbohydrates and dissipated during respiration cannot be replaced. Since the maintenance of health and vitality prevents the breakdown of the cellulose membranes surrounding the fluid-containing cells of the plants and the consequent rapid diffusion of the fluids to the surface, and since the restriction of respiration cuts down the heat generation that accelerates evaporation, keeping produce in a healthy state of dormancy retards the mechanical processes leading to loss of water as well as the chemical processes leading to its generation.

Uniform distribution of the air passing slowly through the compartment causes a considerable lag of the temperature variations in the compartment behind the temperature variations of the outer atmosphere. Thus the variations of the temperature of the produce are more gradual and more limited in range than the variations outside. When a lag of about twenty-four hours is attained, the situation is ideal, because an unusually low or high temperature of the incoming air on any one day cannot have much effect on the produce before being counterbalanced by the more normal temperature of the atmosphere on the succeeding day.

The inducement of dormancy by restriction of air flow causes the produce to respond more and more slowly to temperature changes, so that it is capable of withstanding changes rapid enough to be injurious to produce rot in a dormant state. In addition, healthy fruits and vegetables are to some extent able to regulate their own temperature, like animals. Uniform, slow aeration of a compartment can be used to keep its temperature as low on hot days as it could be kept by ventilation with a much greater air flow, because ventilation involves the production of localized rapid air currents which increase conduction through the compartment walls. These air currents also cause excessive respiration of the produce which they contact.

Although a thermally insulating film of still air may exist along the inner surfaces of the compartment walls when the air flow is very uniform, it is preferable for the walls of the storage compartment to be provided with insulation. A heat reflecting outer surface, such as that obtained by painting the exterior of the compartment a light color, is of still more importance that insulation when the compartment is subject to intense heat radiation from the sun or other sources. The essential feature, however, is uniform distribution of the air flow. The system for uniform distribution of the air flow disclosed herein can be made efficient enough for perfect aeration of the largest chambers.

It is important that the temperature of the produce in a storage compartment be prevented from getting below the dew point of the incoming air, so that moisture may not be condensed thereon.

Moisture on produce favors the growth of the common types of mold. In addition a film of water plugs the microscopic breathing pores on the surface of the produce, and causes suffocation just as surely as the interruption of the supply of fresh air. Breaking down of the cellulose walls surrounding the liquid-containing cells in the interior is the result, so that the produce becomes water-logged under the surface. Then the condition of the produce cannot be changed by the drying of the outer surface. Thus, the flooded interior cells degrade, and the health as well as the flavor of the produce is lost.

It has been discovered that the temperature in the compartment can be prevented from getting below the dew point of the outer atmosphere in case of a sudden rise in the outside temperature by controlling the rate at which the air flows through the compartment. The respiration of the produce tends to keep its temperature slightly higher than that of the incoming air. When the rate of flow of the air is moderately increased, the augmented respiration makes the rate of generation of heat by the produce rise even faster than the rate of air flow. Thus the air is heated even more, and the greater air flow prevents the temperature variations in the compartment from lagging materially behind the outside temperature variations.

Precipitation of moisture upon the produce is prevented in accordance with the invention by an increase in the air flow through the storage compartment whenever precipitation threatens. It is not desirable, however, to keep the air flowing at the increased rate any longer than necessary, because of the high rate of consumption of carbohydrates that accompanies the increased flow. If severe drops in the temperature of the produce can be prevented, no extended periods of increased air flow will be required during the subsequent sharp rises in the outside temperature. In accordance with the invention, the air flow is decreased to the absolute minimum needed to keep the produce alive, whenever necessary to prevent a drop in the temperature of the produce. The air flow is preferably so decreased whenever the temperature of the produce falls below a predetermined value. In the case of Irish potatoes, for example, this value would be about 45° Fahrenheit.

The produce can thus be prevented from cooling down materially during a one or two day period of cold weather. Longer periods of reduced temperature are not likely to be followed by abrupt temperature rises. Freezing of the produce can also be prevented during periods of one or two days in which the outside temperature is below 32° Fahrenheit, and longer periods of freezing weather are not likely to occur during shipment of produce from semi-tropical or tropical producing regions to colder zones of consumption. For extended periods of storage during freezing weather, artificial heating would, of course, be required to keep the produce alive.

For citrous fruit the transition from the orchard temperature to the temperature that is to prevail in the storage compartment should extend over about three days. Although the wound reaction, which takes place after the fruit is picked and involves plugging of the wound, is more satisfactory when the change in temperature is very slow, a twenty-four hour period can be made to suffice for the transition to the storage temperature without serious injury to the fruit.

Even chilled produce can be restored to dormancy by gradual elevation of its temperature to a normal value, providing it has not been killed. A current of dry air should be used to warm the produce and at the same time to remove the film of condensed water that always forms on refrigerated goods when they meet warm air. Chilled celery, for example, may thus be brought from 45° to 70° F. in the course of three or four hours.

An experiment that was conducted to ascertain the condition of oranges after preservation for one to four months in accordance with the invention, and the condition of oranges after similar periods of cold storage demonstrated the superiority of the results obtainable by preservation of the fruit in accordance with the invention.

Oranges so preserved remained firm, and examination of the juice of specimens removed from the stored fruit at the end of periods of one month, three months and four months showed it to be bright yellow. The juice of oranges kept in cold storage, however, was found to have become thinner, darker, and less turbid than the juice of the fresh fruit. After one month of cold storage, the inner rind and a portion of the pulp were also found to have become discolored, and after three months the pulp was waterlogged.

The results of the experiments are tabulated below:

RESULTS FROM PRESERVATION IN ACCORDANCE WITH THE INVENTION.

Months of Storage	Total Solids %	Available Reducing Sugar %	Total Sugar %	Alcohol %	Citric Acid %	% Moisture in Rind	% Moisture in Pulp
None	14.25	5.4	9.8	.05	1.3	—	—
One	14.2	5.2	11.2	.05	1.2	—	—
Three	13.67	5	10.9	.05	1.73	—	—
Four	13.99	5.3	9.31	.11	.83	64.57	80.69
RESULTS FROM COLD STORAGE AT 36° F.							
Two	14.07	6.75	8.6	.53	1.1	62	79.79
Three	11.63	6.4	7.9	.95	.89	80.63	79.1
Four	10.7	6	6.75	.97	1.15	82	83

The rapid decline in total sugar and total solids of the fruit that was kept in cold storage was evidence of undue wasting of its substance. Alcoholic fermentation caused the concentration of alcohol in this fruit to rise to ten or twenty times its normal value.

Ripe fruit, when ready to fall from the tree, is in a dormant condition, and has a low rate of respiration. Its rind prevents it from losing moisture rapidly, so that it can easily be preserved in accordance with the invention for weeks or even months. Leafy vegetables or flowers, on the other hand, are not in dormant condition when picked, and in addition are mutilated in most instances by the severing of the roots. Although they absorb moisture from the atmosphere, under favorable conditions, more rapidly than fruit, their respiration is at a relatively high rate.

The rapid respiration of leafy vegetables may make necessary many changes of the air in the storage compartment every hour to prevent the carbon dioxide concentration in the compartment from rising materially above that of the outer atmosphere. In the case of fruit, however, one change of the air every four hours may be sufficient to prevent an undue rise in the carbon dioxide concentration. A storage compartment used in transportation and warehousing, is preferably filled with only one kind of vegetable or fruit, so that an air flow just sufficient to keep the carbon dioxide concentration in the compartment near that of the outer atmosphere is exactly suited to the produce.

When different varieties have to be stored in the same compartment, the air flow necessary to maintain the proper concentration of carbon dioxide may not be the air flow best suited to all of the produce, but it will preserve all the different fruits and vegetables in the compartment long enough for ordinary requirements.

Fig. 1 of the drawings shows an insulated compartment 10 which is preferably provided with a light colored, heat reflecting outer surface. A door 11 gives access to the interior which may contain shelves 12 for supporting produce. In order to permit a uniform flow of air through the compartment, the shelves are provided with closely spaced perforations. Perforated shelves are preferable to shelves made of mesh because they do not leave marks upon produce placed thereon.

Air is passed through the compartment in a uniform flow by introduction thereof at an approximately equal rate through each of a plurality of equal sections of the upper wall 13 of the compartment. The air is led by a propelling device through a number of conduits 14, nine in the illustrated embodiment, each of which is connected to one of the equal sections of the upper wall 13. Although the frictional resistance to the air is greater for the longer conduits than for the shorter conduits, the friction offered to the slow flow of air in each conduit is so little, in spite of the small diameter, that it may be neglected and the conduits may be made equal in size. The other ends of the conduits are joined together. Thus, the conduits may pass through a wall 15, which partitions off an air distribution box.

A device for creating a pressure differential between the distribution box and the compartment, such as a fan 16, is provided. In order that there may be an equal air flow through each of the conduits, a baffle 17 may be necessary. Air is preferably passed through the bottom wall 18 of the compartment by means of a similar series of conduits 19 leading directly from the atmosphere. Although

the arrangement may be reversed, and the distribution box located at the bottom of the compartment, an upward flow of the air is generally most satisfactory, and the air in any case is preferably drawn rather than propelled through the compartment.

The preferred air distribution system illustrated in the drawings makes possible the maintenance of a uniform pressure throughout the compartment, and a distribution of the air flow so uniform that a lighted candle in the compartment would have its flame little disturbed even though the air were being completely renewed six times every hour.

Fig. 2 shows a larger compartment provided with an air distribution system similar to that of Fig. 1, which is not illustrated in detail. The walls 20 of this compartment, however, are not insulated. A door 21 provides access to the interior and a false floor 22 is penetrated by a series of conduits 23. These conduits serve to lead the air uniformly through the false floor of the compartment, and they may have flaring apertures 24 to facilitate the distribution of the air that leaves the conduits. A similar series of conduits 25 leads the air outward through the false ceiling 26. The produce may be supported in the compartment by packing it in stacked rectangular boxes 27, each of which is open at the top and has a perforated bottom 28 to permit uniform upward flow of the air.

The compartments shown in Fig. 1 and Fig. 3 may be provided with temperature-responsive means for decreasing the rate of air flow when necessary to prevent chilling of the produce, or for increasing the rate of flow when necessary to prevent condensation of moisture thereon.

An electric motor 29 for driving the fan or blower may be supplied with current from line wires 30 (Fig. 4). In series with the motor may be a resistance 31 that is short-circuited by a thermostat 32, whenever the temperature in the compartment is above a certain value. A second resistance 33 may also be placed in series with the motor, and a differential thermostat 34 of any desired type provided to short-circuit both resistances whenever the dew point of the outer atmosphere approaches the temperature in the compartment.

When the system is used in a region of high humidity, it may be found satisfactory for the differential thermostat to short-circuit the two resistances when the dry-bulb temperature of the outside air rises as high as the temperature in the compartment. The dew point of the outside air would then obviously be approaching the temperature of the produce. Under other conditions it may be found more desirable to have the differential thermostat actuated when the wet-bulb temperature of the outer atmosphere gets as high as the inside temperature.

Instead of a differential thermostat, a humidistat could, of course, be used to short-circuit the resistances whenever the relative himidity in the compartment approached saturation. The differential thermostat is preferable because the humidistat would cause the air flow to be stepped up unnecessarily often.

No matter what the relative himidity inside the compartment might be, it would be impossible for precipitation to occur unless the dew point of the outside air were as high as the temperature in the compartment, for the air continually entering the compartment would mingle with the air inside and thus assume the temperature of that air. If in so doing it were not cooled below its original dew point, it would never reach its dew point, because it would stop absorbing moisture from the produce before taking up enough to become saturated.

The thermostat 32 and its lead wires may be omitted from the system when it is used in a region where the temperature never approaches freezing. On the other hand, the differential thermostat with its lead wires could be omitted from the system shown in Fig. 4 in case the prevailing humidity is so low or the outside temperature variations are so gradual as to make it unnecessary. In that case there would need to be only the first resistance 31 in series with the motor.

The present invention provides a method and apparatus which may be employed advantageously by shippers, warehousemen, and retailers of produce because such method and apparatus are simple and inexpensive, yet highly efficient.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of preserving products of the soil that comprises continuously withdrawing air from the outer atmosphere, distributing it to produce a substantially uniform flow, and then passing it through the products at a rate that is approximately just sufficient to keep the carbon dioxide concentration near that of the outer atmosphere, to hold the relative humidity within a proper range and to prevent rapid changes in temperature.

2. A method of preserving products of the soil that comprises continuously withdrawing air from the outer atmosphere,

passing it in a uniformly distributed flow through the products at a rate that is approximately just sufficient to keep the carbon dioxide concentration of the air surrounding the products near that of the outer atmosphere, and regulating the rate of flow to minimize chilling of the products, and to prevent condensation of moisture upon them.

3. A method of preserving products of the soil that comprises continuously withdrawing air from the outer atmosphere, passing it through the products in a uniformly distributed flow, at a rate that is approximately just sufficient to keep the carbon dioxide concentration of the air surrounding the products near that of the outer atmosphere, and increasing the rate of flow when necessary to prevent condensation of moisture upon the products.

4. A method of preserving products of the soil that comprises continuously withdrawing air from the outer atmosphere, distributing it to produce a substantially uniform flow, passing it through the products at a rate that is approximately just sufficient to keep the carbon dioxide concentration near that of the outer atmosphere, and decreasing the rate of flow whenever the temperature of the products falls below a predetermined normal range, to minimize chilling of the products.

5. A method of preserving products of the soil that comprises continuously passing air from the outer atmosphere through the products in a slow uniformly distributed flow, increasing the rate of flow of such air whenever the dew point of the outer atmosphere approaches the temperature of the products, and decreasing the rate of flow of such air whenever the temperature of the products falls below a predetermined normal range.

6. Apparatus for preserving products of the soil comprising a storage compartment for such products, means for continuously withdrawing air from the outer atmosphere and passing it through the compartment at a rate that is approximately just sufficient to keep the carbon dioxide concentration in the compartment near that of the outer atmosphere, and means for distributing the air so that it passes through the compartment in a uniform flow, to prevent the temperature in the compartment from varying as rapidly as the temperature of the outer atmosphere.

7. Apparatus for preserving products of the soil comprising a storage compartment for such products, means for withdrawing air continuously from the outer atmosphere, means for passing it through the compartment in a uniformly distributed flow, at a rate that is approximately just sufficient to keep the carbon dioxide concentration in the compartment near that of the outer atmosphere, and means for regulating the rate of flow to minimize chilling of the products, and to prevent condensation of moisture upon them.

8. Apparatus for preserving products of the soil according to claim 6 or 7 having temperature responsive means within the storage compartment for decreasing the rate of flow of air through the compartment whenever the temperature in the compartment falls below a predetermined normal range.

9. Apparatus for preserving products of the soil according to claim 6, 7 or 8 having temperature responsive means for increasing the rate of flow of air through the compartment whenever the dew point of the outside air approaches the temperature in the storage compartment.

10. Apparatus for preserving products of the soil according to claim 6, 7, 8 or 9 in which the storage compartment is thermally insulated.

11. Apparatus for preserving products of the soil according to claim 6, 7, 8 or 9 in which the storage compartment has a light-colored or other heat reflecting outer surface.

12. Apparatus for preserving products of the soil according to any one of claims 6 to 11 having means for introducing the air uniformly through a substantial area of the walls of the storage compartment.

13. Apparatus for preserving products of the soil according to claim 12 in which the means for introducing the air is divided so as to pass the air through each of a plurality of equal sections of the substantial area of the walls of the storage compartment.

14. Method of preserving products of the soil substantially as hereinbefore described with reference to the accompanying drawings.

15. Apparatus for preserving products of the soil substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 12th day of April, 1937.

For the Applicants,
LLOYD WISE & CO.,
10, New Court, Lincoln's Inn London, W.C.
Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1939.

Fig.1

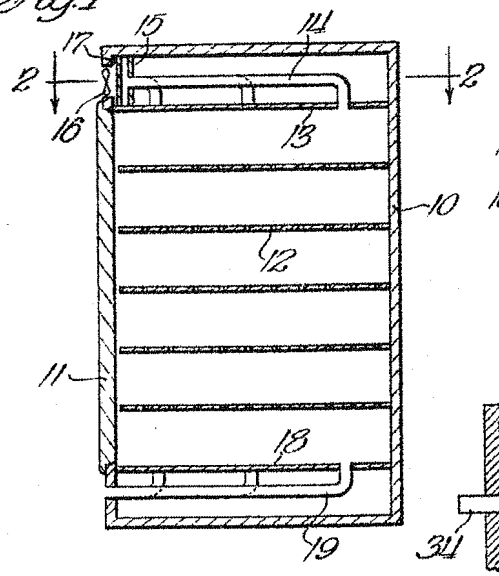
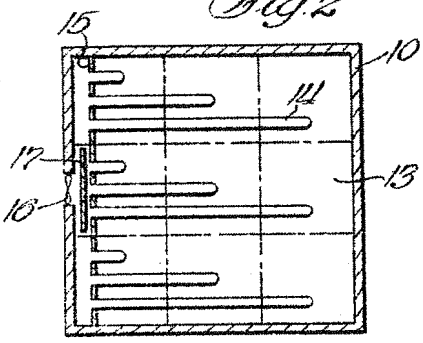


Fig.2



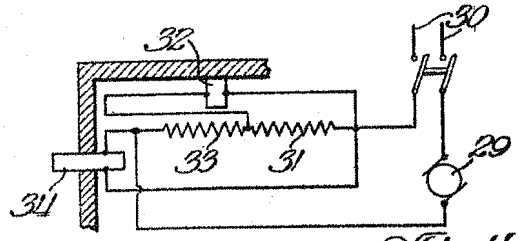
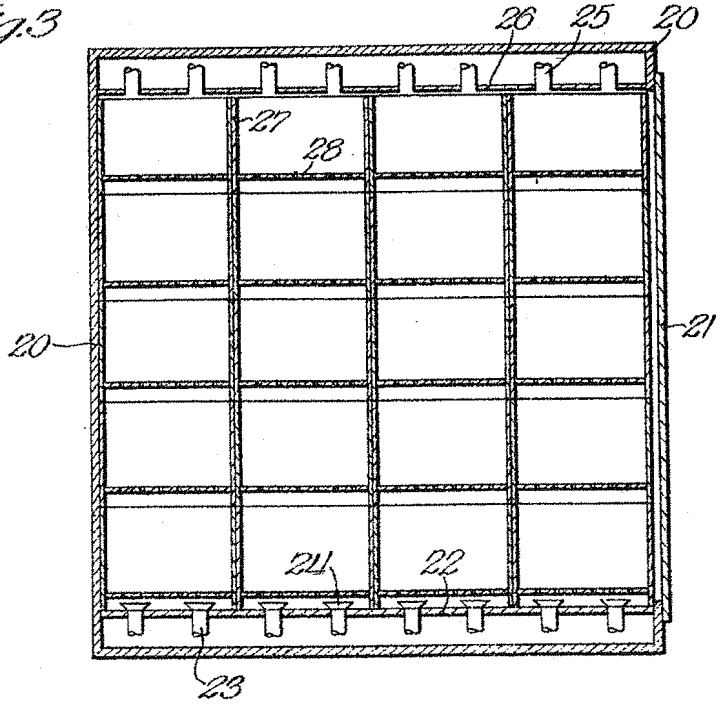


Fig.4

Fig.3



Malby & Sons Photo-Litho